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A MATHEMATICAL CRITIQUE OF SOME PHYSICAL THEORIES[1]

THE purpose of this paper was to review some of the mathematical-physical theories of the past and of the present, indicating briefly the nature of certain concepts upon which these theories rest as well as attendant logical difficulties, and proposing certain modifications. It goes without saying that geometry is the first and simplest of such theories. Some day, when the field of knowledge has extended so far that simplification becomes necessary, ordinary geometry may be approached somewhat as follows:

(1) Geometry treats of elements called *points* and the relation called *distance* between pairs of points.

(2) The complete tabulation of distances between pairs of points may be arranged as follows:

(a) the points P correspond to real number triples (x, y, z);

(b) the squared distance between P_1 and P_2 is

$$(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2.$$

All geometry follows very readily from these agreements. Beginning in this way one may successively define line-segments, lines, planes, perpendicularity, rectangular coordinate systems, etc. The whole body of geometrical fact with corresponding analytic framework is easily deducible, and yet one may stop at the fundamental principles without taking up beautiful but less vital geometrical studies. In its origin the geometrical concept of space is always to be associated with that of a corresponding body of reference.

Classical dynamics arises in the attempt to use Euclidean space and absolute time as the means for expressing the laws of nature. There lie certain fundamental difficulties at the very basis of this attempt to make space the container of matter. The simplest illustration of them arises in dealing with a collection of "equal rigid elastic spheres." When only two spheres collide, the assumed laws of contact action determine uniquely their directions and velocities after collision; but when more than two spheres collide, the situation is entirely different.

[1] Synopsis of address as retiring president of the American Mathematical Society before a joint meeting of the American Association for the Advancement of Science, the American Mathematical Society and the Mathematical Association of America. The full text will appear in an early number of the *Bulletin of the American Mathematical Society.*

Suppose that three equal spheres approach a point with equal velocities, the lines of motion being 120° apart and in the same place. If all three spheres collide at the same instant, considerations of symmetry alone demand that the spheres must rebound back along the same lines with a velocity equal to that of approach. But it is easily verified that if two of them collide ever so little before they collide with the third, the resultant motion will be decidedly different in character. Such a result seems to contradict the fundamental physical requirement of continuity. In fact the laws of action suffice to determine the behavior of two spheres which collide, but as more and more complicated simultaneous collisions between three or more spheres are considered, it is not possible to infer their behavior by an argument based on continuity or even symmetry, so that these laws need to be supplemented by indefinitely many others of arbitrary type, if the mathematical theory is to be determinate.

The situation is similar with n mass particles, attracting one another according to the Newtonian law; and the concept of elastic bodies so fundamental in classical dynamics presents even more formidable logical objections. For example, suppose that two equal elastic spheres under no pressure approach along their line of centers with equal velocities which exceed the disturbance velocity. The parts of the spheres which collide can not then rebound without interpenetration. Thus it appears as if the spheres are converted into a kind of lamina of infinite density moving radially outward in the plane of symmetry. But this yields a total change of state, which the theory of elasticity does not contemplate.

These illustrations show that the classical theory of particles, rigid and elastic bodies, needs to be supplemented by further conditions if the central difficulty of indeterminateness is to be avoided, and also that such further conditions will of necessity be artificial in character. The question now arises: Is it possible to conceive of simple laws of motion for systems of particles, and for continuous bodies in empty space, which will be unified and determinate? To secure such a system of particles it suffices to assume that in addition to the ordinary Newtonian force of attraction there is a repulsive force inversely proportional to the cube of the distance. Since the potential energy of the system then increases indefinitely when any two particles approach collision, it follows that collision can never take place. In order to deal with a continuous distribution of matter, we may assume that the law of force for the continuous distribution is the same as for the system of particles just considered. It is obvious that such a fluid can not contract indefinitely since then its potential energy would exceed the total initial energy; nor can it expand indefinitely unless sufficient kinetic energy is available. Evidently this fluid is entirely different in character from the elastic body under pressure, but it has at least the theoretical advantage of being free from indeterminateness. Two colliding bodies of this description will in general separate after a transitional period of interpenetration.

The chief mathematical instruments used by the physicists in dealing with space, time and matter in classical physics have been the Lagrangian and Hamiltonian equations. Poincaré proved it to be a general characteristic of equations of this type that small disturbances from stable periodic motion are essentially periodic.

It may be proved conversely that if a dynamical system is such that its state is determined by 2n coordinates, and if the perturbations from a periodic motion can be represented by trigonometric series, then the equations may be given Hamiltonian form.[2] Thus perhaps the only significance of the Hamiltonian form of equations in classical dynamics is to insure automatically that the perturbations of certain periodic motions are oscillatory.

The equations of Maxwell, giving the interplay between the electric and magnetic forces in space, have never been modified. The space-time background appropriate to this form is that of the special theory of relativity, in which space and time are taken relative to some reference body and in which the velocity of light appears as a characteristic limiting disturbance velocity.

In the simple case of a number of electrified particles, there will be an indefinite radiation outward of electromagnetic energy as oppositely electrified particles fall into one another, while those similarly electrified tend to separate indefinitely under the mutual forces of repulsion. Evidently such a system of electrified particles is of little physical interest.

The use of an elastic fluid under tension as the carrier of electricity seems at first sight to offer prospects of success. Further examination of the problem shows that it is impossible to secure stability of the kind desired, no matter what the relation between tension and density may be. But, aside from this instability, which arises from the fact that electricity of one sign exerts strong forces of repulsion upon itself, there is another difficulty which arises even in the consideration of neutral matter. In fact, there are two types of disturbance velocities, firstly, that of light and, secondly, that of the elastic wave of

[2] *Cf.* Paris *Comptes rendus*, September 20, 1926, and a paper which is about to appear in the *American Journal of Mathematics* for January, 1927.

the fluid. The same paradox might arise at collision as in the analogous classical situation.

The only possible elastic fluid would therefore seem to be one with a disturbance velocity equal to that of light at all densities. The fluid of this type may be termed the "perfect fluid," by analogy with the ordinary perfect gas. The expansive pressure is such a fluid is readily determined to be one half the density in absolute units, and so enormously great; on account of the relativistic character of this perfect fluid, the mass of a small part of it is not invariable but changes as the square of the density of the attached charge. Obviously the perfect fluid is a highly instable carrier of electricity.

The failure of attempts to make use of an elastic fluid as the carrier of electricity leads one to inquire whether it is not in the nature of the case that the elementary bodies such as the protons and electrons must have some sort of autonomous existence. Now the kinetic and elastic energy of the perfect fluid at low velocities can be defined, in such wise that the principle of conservation of energy holds. Let us suppose in addition that there is an individual "atomic potential" energy of positive volume density, ψ, where ψ has a value fixed for all time at each point of the fluid. This leads to a supplementary body force, proportional to the gradient of ψ in space, and also to a surface pressure inward, proportional to ψ. In this way indefinite expansion is prevented, for it would involve an indefinite increase in the atomic potential energy.

At first sight this seems to insure a stable spherical form of equilibrium. However, further examination shows that the nucleus is amorphous under radial displacement. But now suppose that the protons are made of very small parts of the fluid with charge $+e$, while the electrons are also made of parts of the fluid carrying the charge $-e$, both with suitable atomic potentials. Let us suppose furthermore that such an electron can be penetrated freely by the proton. Under these circumstances there will be a stable spherical form of equilibrium, in which the proton coincides with the electron; the tendency towards amorphous shape of the electrons and protons will be destroyed by the attractive forces between them.

Here perhaps is a kind of two substance theory of matter and electricity which will be found to meet the fundamental mathematical requirements of determinateness and stability.

The space-time framework of general relativity is adapted to the concept of atomic potential; for this purpose the energy tensor T_{ij} may be defined as consisting of the elastic and electromagnetic energy tensors due to the protons and electrons, and of a further term, ψg_{ij}, where ψ is the atomic potential.

If we grant the four-dimensional nature of space-time, the argument of continuity seems to make it imperative that the atom is an oscillating electromagnetic system. The central facts about the atomic oscillator are essentially two: first, it acts like a number of simple resonators of perfectly definite frequencies, such as those given by the Balmer formula in the case of the hydrogen atom; and secondly, these frequencies are excited only by means of certain quanta of energy. Now there need be no essential difficulty in accounting for this second fact. Imagine a pendulum to swing in a viscous medium whose viscosity diminishes rapidly as the distance from the position of equilibrium increases. Only with sufficient initial velocity will it oscillate back and forth, traversing the viscous region in damped hormonic motion. Consequently it is possible to conceive of the so-called "energy levels" as defining the amount of energy necessary to carry the oscillators so far from equilibrium that they will move back and forth past the position of equilibrium. Thus the first and most fundamental task appears to be to find an oscillator possessing the desired frequencies. Afterwards one may investigate in detail the rate of electromagnetic radiation, which may correspond to viscosity.

In particular it will be of interest to consider the small oscillations of the fluid proton and electron as specified.[3] The three equations determining the frequencies are analogous in type to the "wave equation" of Schrödinger.

It seems to be of decided importance to develop theories, like the above, which meet the elementary mathematical demands of actual determinateness and stability. This does not seem to have been done in a single case hitherto.

In conclusion the statistical properties of non-Hamiltonian equations were referred to. These seem to be best suited to represent atomic systems taken as possessing a finite number of degrees of freedom; for such equations only can there be a set of periodic motions to which every other motion is in general very near.[4] Hence such differential equations may yield the effect of quantum orbits without any quantum conditions.

GEORGE D. BIRKHOFF

HARVARD UNIVERSITY

[3] A development of the theory outlined will be published in a forthcoming number of the *Proceedings of the National Academy of Sciences*. On proper choice of the "substance coefficients" and "atomic potentials," the theory leads to a formula of Balmer type for the frequencies.

[4] *Cf. Göttinger Nachrichten*, 1926.

THE CHINA FOUNDATION FOR THE PROMOTION OF EDUCATION AND CULTURE

THE First Report (Peking, 1926) of the China Foundation should be widely read by all who are interested in Oriental problems. It constitutes a definite landmark in the development and maintenance of cordial relations between China and the United States. In it will be found a detailed statement of the arrangements which have been made for the expenditure of the unremitted portion of the Chinese Boxer Indemnity, amounting to a little over twelve and a half million dollars United States currency. Of this amount $1,422,217.75 has already been released by the American Government.

Full responsibility for the use of these funds is placed in the China Foundation, an organization established by presidential mandate, consisting, in the first instance, of fifteen trustees, of whom five are Americans and ten are Chinese. According to the constitution, vacancies occurring in the board of trustees shall be filled by election by the trustees. There is no stipulation as to nationality; but an agreement on this point may be contained in some other document. It is provided that "Representatives of the Minister of Foreign Affairs and of the Minister of Education and of the Minister of the United States to China shall have the right to attend the meetings of the board of trustees to observe the proceedings." These representatives are, however, without power, and, according to the published minutes, have not availed themselves of this privilege.

The present American trustees are: Mr. J. E. Baker, Mr. C. R. Bennett, Mr. R. S. Greene, Professor Paul Monroe, and Dr. W. W. Willoughby, the last named having been appointed to take the place of Professor John Dewey, who has resigned. Not all these persons are resident in China. It is to be hoped that they will soon be replaced by Chinese.

The Chinese trustees, with whom the responsibility really lies, are as follows: Dr. W. W. Yen, Dr. V. K. Wellington Koo, Dr. Sao-Ke Alfred Sze, Mr. Fan Yuan-lien, Dr. Huang Yen-pei, Dr. Chiang Monlin, Dr. Chang Poling, Dr. P. W. Kuo, Dr. V. K. Ting, and Mr. Y. T. Tsur.

Probably no other group of ten Chinese could be chosen in which Chinese and foreigners, alike, would repose such implicit confidence. It will be recalled that Dr. W. W. Yen is the distinguished and internationally well-known Chinese minister of foreign affairs, that Dr. V. K. Wellington Koo is the Chinese minister to Great Britain, and that Dr. Sao-Ke Alfred Sze is Chinese minister to the United States. Mr. Fan Yuan-lien, the director of the foundation, has had much experience as minister of education. Dr. Chang Poling is president of the Nankai College and Dr. P. W. Kuo is president of the National Southeastern University, two institutions financed and controlled by Chinese and worthy of the highest praise. Dr. V. K. Ting is director of the Geological Survey. Mr. Y. T. Tsur is a well-known banker. Indeed, almost every important walk of life is represented by a leader in it. Most of the members have attended foreign universities: one in Japan, one in both England and Germany, and at least six in the United States. Many of them have been and still are teachers. No one can deny that these trustees are qualified to deal wisely with problems of education.

It has been unanimously resolved by the trustees that these indemnity funds shall "be devoted to the development of scientific knowledge and to the application of such knowledge to the conditions in China through the promotion of technical training, of scientific research, experimentation and demonstration, and training in science teaching, and to the advancement of cultural enterprises of a permanent character, such as libraries, and the like."

In order, perhaps, that this remission by the United States shall stand as a permanent gesture of good will, the trustees have decided to establish a permanent endowment fund "to consist of present accumulations, plus an annual addition sufficient to provide at the end of twenty years a principal which will yield an annual income of about half a million gold dollars."

Grants made during the year 1926–1927 amount to $850,000 silver (approximately $400,000 United States currency). The largest item is $250,000, being the first of four annual contributions toward the establishment of a Metropolitan Library in Peking, in fulfillment of a definite agreement with the Ministry of Education. The National Southeastern University receives a total of $184,000, Nanyang University, $50,000, Hsiang Ya Medical College, $45,000, and the China Institute in America, $30,000. Other grants are made for special purposes, but the disbursements are in no sense diffuse. Each is directed to a concrete purpose, preference being given "to existing institutions with a record of efficient service and administration, rather than to newly founded institutions which base their applications solely on future prospects."

Never before have such large funds been placed under Chinese control for philanthropic purposes by foreigners, but, in consideration of the personnel of the board, the outlook is very bright. The masterly administration of the North Manchurian Plague Prevention Service from its inception on October 1, 1912, by its director, Dr. Wu Lien Teh, and the continuity of its activities through periods of famine, foreign

aggression, revolution and civil war show what may be accomplished with the aid of a regular source of income, in this case from the customs revenue, which is principally collected under foreign supervision.

Both of these great enterprises have been initiated as emergency measures, and it can not be said that one is more urgently demanded than the other. Without the North Manchurian Plague Prevention Service the whole of North China would be periodically decimated by plague. The China Foundation commences to foster education at a time when such help is sorely needed. Without education, China can never take her rightful place in the community of nations. Just at present, on account of the wide-spread political unrest, the proper financing of education through taxation is impossible. The help so timely given by the American Government through the China Foundation may indeed be instrumental in saving many absolutely essential educational enterprises from complete extinction.

E. V. COWDRY

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

CHARLES CLEVELAND NUTTING

EARLY in the evening of January 23, Professor C. C. Nutting, of the department of zoology at the State University of Iowa, passed away at his home in Iowa City in the sixty-ninth year of his age. Angina pectoris was given as the cause of death.

Professor Nutting was born at Jacksonville, Illinois, May 25, 1858. He attended Blackburn College, receiving his B.A. degree from that institution in 1880 and his M.A. degree two years later.

In the autumn of 1886 Mr. Nutting joined the University of Iowa staff as professor of zoology and curator of the museum of natural history. Four years later he was made head of the department of zoology which position, together with the curatorship of the museum, he was destined to hold for thirty-six energetic and fruitful years. At the end of the school year of 1925–26 he relinquished his post as head of the zoology department and curator of the museum but retained his teaching duties in which he was actively engaged up to five days before his death.

Between 1881 and 1886, exploration, research and collecting trips to Central America and Florida afforded Nutting an opportunity for indulging his natural history bent as well as occasion for acquiring a variety of observations and experiences which served as material to enliven and enrich his class room work and public lectures as long as he lived. While at the University of Iowa he early devoted his attentions to the building up of a zoological museum in the interest of which he visited the West Indies and various parts of North America for the purpose of collecting specimens. Perhaps his most notable effort of this kind was made in 1893 when he promoted and carried to a successful conclusion a research and collecting trip to the Bahama Islands. The party of twenty-three persons was made up largely of students and staff members of the University of Iowa. He later headed two similar university enterprises, the Barbados-Antigua Expedition in 1918 with a personnel of nineteen and the Fiji-New Zealand Expedition in 1922 made up of six persons.

In the pursuit of his special studies Professor Nutting visited many marine laboratories. Woods Hole, Massachusetts, Plymouth, England, Naples, Italy, La Jolla, California, Honolulu, T. H., and their adjacent seas all claimed his attention at one time or another during his association with the University of Iowa.

The death of Professor Nutting robs science of one of her most active and prolific workers in the field of systematic marine zoology. His particular interest was in the Coelenterata. The list of his published papers is a long one but his monograph on the "American Hydroids," Parts I, II and III, issued as Special Bulletins of the United States National Museum, 1900–1915 and the "Gorgonacea of the Siboga Expedition," Parts III to VIII, 1910–1911, should receive special mention. His researches have thrown considerable light on the morphology, distribution and relationships of these marine forms. That he was actively engaged in such investigations until almost the end is attested by the fact that he had, only a few days ago, read proof of a forthcoming report on Philippine hydroids. Probably his most popular and widely read publications have been his "Narratives" of the Bahama, Barbados-Antigua and Fiji-New Zealand expeditions. These books are written in easy readable style and are exceedingly informational. In his later years several papers of a philosophic nature appeared from his pen.

Professor Nutting was a member of many scientific bodies and frequently attended their meetings and contributed to their publications. He had served as president of the Central Branch of the American Society of Zoologists, the Iowa Academy of Science and the Iowa Chapter of Sigma Xi. Among the university organizations to which he belonged, he took special interest in the Baconian Club; he was one of the founders and a past president of the society. In church work he also took an active and energetic part.

This man truly *lived*. He gave much and he derived great satisfaction from the giving. His pioneer work in museum building and zoological investigation at the University of Iowa has been of inestimable value to the institution, its alumni and friends. As

a teacher and research worker his energy and enthusiasm aroused those qualities in others as the legion of successful men and women who have come under his tutelage will testify.

In recognition of his distinguished service to science, Cornell College, Mount Vernon, Iowa, conferred upon Professor Nutting an honorary LL.D. degree in 1926.

Professor Nutting is survived by his widow, Eloise Willis, whom he married in 1897; a daughter, Miss Elizabeth H. Nutting, member of the faculty at Boston University; and two sons, the Reverend Willis D. Nutting, Evergreen, Colorado, and Charles B. Nutting, a student at the University of Iowa. A brother and four sisters also survive.

DAYTON STONER

SCIENTIFIC EVENTS

THE RICHMOND MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE seventy-third meeting of the American Chemical Society will be held in Richmond, Va., from April 11 to 16.

All divisions except the cellulose, colloid, fertilizer, leather and gelatin, and sugar divisions will hold separate meetings. Papers which would normally be assigned to these divisions of an industrial nature will be placed on the program of the Industrial Division, while any scientific papers normally going to these divisions will be assigned to the organic, physical and inorganic, or other appropriate programs.

On Tuesday afternoon three general divisional meetings, and possibly a fourth, will be held. The division of industrial and engineering chemistry, the division of physical and inorganic chemistry and the division of organic chemistry jointly with the division of biological chemistry will present general programs of interest to all members. Other divisional meetings will come on Wednesday and Thursday as usual.

The division of agricultural and food chemistry, in addition to its regular program, on Wednesday afternoon will hold a symposium jointly with the division of biological chemistry, on the "Chemistry of Plant Life as it affects Food," with C. A. Browne as chairman.

The division of biological chemistry, in addition to its regular program, will meet jointly Tuesday afternoon with the division of organic chemistry and on Wednesday afternoon with the division of agricultural and food chemistry, as announced under these divisions.

The division of dye chemistry is planning an extensive program with special reference to the fact that Richmond is in the southern textile center. Topics of interest to textile manufacturers will, therefore, be included in the program. Other features will be a discussion of "What is Invention in the Field of Organic Chemistry?"—a consideration of the present system of dye patents, several papers on certain phases of dye manufacture, as well as the usual contributions on subjects of theoretical and laboratory interest.

The division of industrial and engineering chemistry will hold a symposium on "Lime," with J. R. Withrow as chairman. Many prominent authorities in the field of production and utilization of lime have already agreed to take part in this symposium.

The division of organic chemistry will hold five half-day sessions, including a general session on Tuesday afternoon in conjunction with the division of biological chemistry, and one jointly with the division of chemical education in a symposium on "The Teaching of Organic Chemistry."

The division of physical and inorganic chemistry is arranging an interesting program. There will be a special illustrated lecture upon the subject of "High Power Metallography and the Ultra-Violet Microscopy," by F. F. Lucas, of the Bell Telephone Laboratories.

The division of water sewage and sanitation plans a discussion of the preservation of water mains and the prevention of troubles caused by the corrosion of pipes. This will be opened with a paper presented by John R. Baylis on the treatment of public water supplies to render them non-corrosive.

The history of chemistry section has already had promises of papers by Avery A. Ashdown, R. N. Brackett, Tenney L. Davis, F. P. Dunnington, William Foster and Edgar F. Smith, and anticipates an especially interesting session.

The division of chemical education will join with the division of organic chemistry in a symposium on "The Teaching of Organic Chemistry" and will meet one half-day with the history of chemistry section. At one session the question of cooperation of local sections with teachers of chemistry will be discussed, at which the chairmen and secretaries of local sections are especially invited to be present.

The secretaries of the divisions and sections which will hold meetings are as follows:

Agricultural and food chemistry, C. S. Brinton, Food Inspection Laboratory, U. S. Appraisers Stores, Philadelphia.

Biological chemistry, Paul E. Howe, Bureau of Animal Industry, Washington, D. C.

Chemical education, Ross A. Baker, Bowne Hall, Syracuse University.

Dye chemistry, H. T. Herrick, Color Laboratory, U. S. Bureau of Chemistry.

Gas and fuel chemistry, O. O. Malleis, 5557 Woodmont St., Pittsburgh.

Industrial and engineering chemistry, E. M. Billings, 343 State St., Rochester, N. Y.

Medicinal products chemistry, A. W. Dox, Research Laboratories, Parke, Davis & Co., Detroit.

Organic chemistry, Frank C. Whitmore, 1812 Chicago Ave., Evanston, Ill.

Petroleum chemistry, F. W. Padgett, 433 Tahoma Ave., Norman, Okla.

Physical and inorganic chemistry, Victor K. LaMer, 353 Moore Ave., Leonia, N. J.

Rubber chemistry, A. H. Smith, 611 Peoples Savings and Trust Bldg., Akron, Ohio.

Water, sewage, and sanitation chemistry, W. D. Hatfield, 305 Linden Place, Decatur, Ill.

History of chemistry, Tenney L. Davis, Massachusetts Institute of Technology, Cambridge.

Paint and varnish chemistry, P. E. Marling, Lowe Brothers Co., Dayton, Ohio.

A GEOLOGICAL EXCURSION IN TEXAS

THE bureau of economic geology of the University of Texas and the West Texas Geological Society sponsored jointly a geological excursion and conference on January 8 and 9, 1927. The party assembled at San Saba on January 7 and disbanded at San Angelo on January 9, having examined selected exposures of formations ranging in age from the Algonkian to the Triassic. One hundred and fifty geologists participated. These were mostly from Texas, although New Mexico, Oklahoma and Louisiana had representatives. Visiting geologists were Professor Charles Schuchert, of Yale University; Dr. Julia Gardner, of the United States Geological Survey, and Dr. Charles N. Gould, state geologist of Oklahoma. Favorable weather enabled the party to make the journey of about 350 miles without delay or mishap. The average number of autos in line was between 50 and 60.

Guides for the party were: J. T. Lonsdale, for the Pre-Cambrian; E. H. Sellards and F. B. Plummer, for the Cambrian, Ordovician, Mississippian and Pennsylvanian; J. W. Beede, for the Permian and Triassic. The principal object of the excursion and conference was to examine typical exposures of formations elsewhere encountered in deep drilling, and to further the correlation of these formations across the southern end of the great salt basin of Texas, New Mexico and Oklahoma. This excursion is the first of a series of field conferences planned by these organizations for this purpose. The second excursion of the series will be made February 26 and 27, at which time formations in the Glass Mountains of Texas on the southwest side of the salt basin will be examined.

AWARD OF PRIZES BY THE SESQUICENTENNIAL EXPOSITION OF PHILADELPHIA

OF the prizes awarded at the recent Sesquicentennial International Exposition, two grand prizes, three medals of honor and nine gold medals, in addition to a number of lesser awards, were won by the General Electric Company. The grand prizes were awarded for "systems of electric transportation and traffic regulation devices," and the other for "excellence of products and service to humanity." One medal of honor was awarded for "Gas-Electric System of Drives for Busses," one for "G.-E. Mazda Lamps" and one for "Turbine Super-Charger." Gold medals were awarded as follows: For "automatic induction voltage regulator as typical of apparatus of this class made by exhibitor"; for "A-C and D-C Motors"; for direct current generator-marine type—as typical of machines of this class made by exhibitor"; for "electric fans of high quality"; for an "electric mine locomotive fitted with automatic cable reel of high efficiency"; for "emergency automatic throw-over switch mounted on vertical steel panel"; for "motor-generator set typical of machines of this class made by exhibitor," and for "type H transformers."

The exhibit of the U. S. Coast and Geodetic Survey at the Sesquicentennial Exposition won two medals for its excellence. The jury of awards conferred a medal of honor for the exhibit as a whole, and a gold medal for the combined models of the wire-drag and sound ranging apparatus used by the survey in its work of charting the floor of the ocean. In addition to the models shown, the exhibit included various instruments used in survey work, an explanation of the marvelous tide-predicting machine which does the work of sixty mathematicians, an exhibit detailing the steps involved in producing nautical charts, and illustrated slides showing work in progress.

The exposition awarded four gold medals to the U. S. Public Health Service for features of its exhibit at the exposition. The awards were made for (1) an exhibition of machines using chlorine gas in connection with drinking water; (2) for life-like vaccination models showing the types of reaction to small-pox vaccination; (3) for the selection of subjects and neatness of display in a collective health exhibit, and (4) for an exhibit of a modern unit for dental surgery. The material that was on display at the exposition is being arranged for display in one of the service buildings in Washington, D. C.

SCIENTIFIC LECTURES AT PASADENA

DURING the autumn the program of the Astronomy and Physics Club of Pasadena has included the following speakers and subjects:

October 15—*Methods of studying electrically exploded wires,* Dr. J. A. Anderson.

October 22—*Refinement of the Michelson-Morley experiment,* Dr. Roy J. Kennedy.

October 27—*Electric discharge in rare gases,* Professor Richard Whittingdon, Cavendish professor of physics, Leeds University.

November 3—*Turbulent motion in fluids,* Dr. T. von Karman, of Aachen, Germany.

November 5—*Heat transfer in moving fluids,* Dr. T. von Karman.

November 12—*The stagger-decalage biplane,* A. A. Merrill.

November 19—*A compound interferometer for fine structure work,* Dr. W. V. Houston.

December 3—*Red stars and their astrophysical significance,* Dr. P. W. Merrill.

December 10—*Mira Ceti,* Professor A. H. Joy.

The lectures on evolution, given under the auspices of Sigma Xi, were:

November 4—*Evolution of life on the earth,* Dr. Chester Stock.

November 18—*Evolution of life on the earth,* Dr. Chester Stock.

December 2—*Evolution of the birds,* Dr. Loye H. Miller.

CHAS. E. ST. JOHN

DINNER IN HONOR OF DR. ERWIN F. SMITH

DR. ERWIN FRINK SMITH, senior pathologist in charge of the pathological laboratory of the Bureau of Plant Industry, a pioneer in the study of the bacterial diseases of plants, was the guest of honor at the annual dinner of the American Phytopathological Society in Philadelphia on December 29. Mrs. Smith shared the honor with him.

In introductory remarks, the president of the society, Dr. I. E. Melhus, professor of plant pathology at Iowa State College, congratulated Dr. Smith upon his extensive contributions to science. Dr. Melhus then called upon Dr. L. R. Jones, chairman of the department of plant pathology of the University of Wisconsin, to speak on Dr. Smith's services to plant pathology. Dr. Jones was followed by Dr. William H. Welch, pathologist of the Johns Hopkins University, who spoke on Dr. Smith's contributions to human and animal pathology. Dr. F. V. Rand, formerly of the Bureau of Plant Industry and now with the publication, *Biological Abstracts,* then, after appropriate remarks, presented to Dr. Smith, in the name of the society, a brochure, in which were engrossed abstracts of the addresses that had just been made, followed by the autographs of the members present.

Dr. Jones said in part:

> For leadership in the early study of peach yellows, most stimulating example of dogged work upon a baffling problem, with prophetic assurance that knowledge of tobacco mosaic and aster yellow was pertinent to the solution. For leadership in pioneer studies of bacterial plant pathogens, with classic publications, exacting models for all who followed. For assembled contributions to knowledge of bacteria in relation to disease in plants. For epochal researches in crown-gall. For sympathetic counsel to eager young scientists, from far and near. For thus exemplifying the Pasteurian characteristics—clear vision, instant action, intuitive judgment, precise method, tireless endeavor, sympathetic patience, self-sacrificing devotion in service through science. For these things we delight to honor you—pioneer, prophet, exemplar, dean of our science.

Dr. Welch said:

> I rejoice in this opportunity to speak in behalf of my fellow workers and colleagues and to bear tribute to the importance and significance to human and animal pathology of your studies devoted primarily to plant diseases. No one in our day has done more to bring these two great divisions of pathology into close relation to their mutual advantage. The field which you have cultivated so successfully, and with which your name will always be associated—the relation of parasitic organisms, especially of bacteria, to the diseases of plants—is one of the broadest biological interest. Above all, your studies of tumors of plants, which you have demonstrated to be of bacterial origin, have brought you into the field of ontology in its broadest aspects. Here you take your place in national and international congresses and associations devoted to cancer research or to medicine in general, and here your work is recognized as of the greatest interest and importance. While your name is associated especially with the championship of the parasitic theory of the origin of tumors, your studies of the mechanism of tumor formation, of problems of histogenesis, of formative stimuli and inhibitions of growth, and other kindred subjects, are scarcely of less importance. It would lead far to tell of the whole debt which medicine and pathology owe to you, but I can not forego mentioning the service which you have rendered in making the life and work of Pasteur readily accessible and familiar to students of medicine and the general public.

SCIENTIFIC NOTES AND NEWS

THE gold medal of the Royal Astronomical Society has been awarded to Professor Frank Schlesinger, of Yale University Observatory, for his work on stellar parallax and astronomical photography.

THE Astronomical Society of the Pacific has awarded the Bruce gold medal "for distinguished services to astronomy" to Dr. Herbert Hall Turner, Savilian professor of astronomy at Oxford University. The award was announced at the annual meeting of the society held on January 29. At this meeting Dr. Paul W. Merrill was elected president of the society for the year 1927.

THE Geographical Society of Chicago has awarded its gold medal to Dr. Isaiah Bowman, director of the American Geographical Society, for "eminent service in the promotion of geography in America." Dr. Bowman addressed the society on February 8, on which occasion the medal was presented.

DR. ALBERT F. BLAKESLEE, of the Carnegie Institu-

tion of Washington, department of genetics, Cold Spring Harbor, N. Y., has been elected a corresponding member of the Biological Society of Paris and an honorary member of the Society of Naturalists of Moscow.

PROFESSOR FRANK P. UNDERHILL, of the department of pharmacology and toxicology at Yale University, has been elected a member of the Kaiserlich Deutsche Academie der Naturforscher zu Halle.

DR. MORRIS FISHBEIN, editor of the *Journal* of the American Medical Association, has been appointed a corresponding member of the Association de la Presse Médicale Belge.

THE Symington prize for anatomy of the Queen's University, Belfast, has, on the advice of the council of the Anatomical Society of Great Britain and Ireland, been awarded to Dr. H. Woollard, of the University of London.

DR. ALEXANDRE BRUNO, Paris, formerly of New York, has been awarded the Clarens prize by the Academy of Medicine of Paris, for his book entitled "Contre Tuberculose."

A MEETING in honor of Robert T. Hill was held by the Branner Club of Los Angeles on January 14, to commemorate the fortieth anniversary of his first paper on the Comanche of Texas, which was read before the Philosophical Society of Washington. Dr. T. Wayland Vaughan, one of Dr. Hill's early assistants, gave a talk on their geological work and some of their experiences during the frontier days of Texas, and Judge F. G. Finlayson spoke on "Dr. Hill as a Man." Dr. Ralph Arnold read several letters from distinguished geologists in various parts of the world who were unable to attend the meeting. F. B. Lippincott and Professors James Wolfe and James Hyde spoke of their appreciation of Dr. Hill. Dr. Frederick P. Vickery presided. Dr. Hill gave a brief reminiscence of his experiences during the early days of Texas, his studies at Cornell, and of his work with the United States Geological Survey.

THE freshman class of the University of Cincinnati College of Medicine recently gave a dinner to celebrate the birthday of Dr. Oscar V. Batson, assistant professor of anatomy.

DR. E. DE GOLYER, petroleum geologist, has been elected president of the American Institute of Mining and Metallurgical Engineers. The institute will hold a meeting in New York City from February 14 to 17.

BANCROFT GHERARDI, vice-president and chief engineer of the American Telephone and Telegraph Company, has been nominated for the office of president of the American Institute of Electrical Engineers.

THE United States Coast and Geodetic Survey has announced its regular bi-yearly transfer of engineer officers in the Philippine Islands: Lieutenants W. F. Malnate, J. A. McCormick and L. C. Wilder go to Manila for a two-year period of service, and Lieutenants O. W. Swainson, R. R. Moore, J. A. Bond and H. A. Paton will return to the United States.

L. H. ALMY has resigned from the U. S. Bureau of Chemistry to carry on research for the H. J. Heinz Company at the headquarters plant in Pittsburgh. A new laboratory for control and research was completed in December.

DR. ELLERY H. HARVEY has been made chief chemist of Montgomery Ward and Company, Chicago.

ROY E. CLAUSEN, associate professor of genetics in the College of Agriculture, University of California, has been invited to make a survey of the European institutions that are engaged in research in genetics for the International Education Board. At the present time, Professor Clausen is at the University of Stockholm, pursuing his study of genetics in the botanical institute of that institution.

PROFESSOR WESLEY R. COE, of the department of zoology at Yale University, who is on sabbatical leave for the current year, is at present engaged on investigations on the invertebrate fauna of the Pacific Coast, with headquarters at the Scripps Institution of Oceanography in California.

DR. E. S. MOORE, professor of economic geology in the University of Toronto, assisted by Mr. J. E. Maynard, is making a special study of the precipitation of iron and silica under natural conditions, by aid of a grant from the National Research Council of Canada.

DR. L. C. DUNN, of the Storrs Agricultural Experiment Station, sailed for Europe on January 8, to spend his sabbatical year in the animal breeding research department of the University of Edinburgh. During his absence, Dr. Dunn will act as representative of the American Genetic Association at the Fifth Annual Genetic Congress, to be held in Berlin next September.

DR. T. D. A. COCKERELL, professor of zoology at the University of Colorado, expects to sail for England next June and thence go to Russia and Siberia; later back to Russia; in October to England, and about November 1 to India and Siam, and about February 1 to Australia and New Zealand by way of South Sea Islands. He will return to Boulder about September 1, 1928.

P. H. DORSETT, agricultural explorer for the United States Department of Agriculture, recently returned to the United States after two and a half years of

searching in China and the tropical islands of Sumatra, Java and Ceylon for plants that may be useful in American agriculture. With the assistance of his son, J. H. Dorsett, he has brought back a large selection of seeds, plants, scions, bulbs, tubers and cuttings.

DR. C. H. MYERS, of the department of plant breeding of Cornell University, addressed the staff of this station on January 21, on his experiences in China while on sabbatical leave during the past year. Dr. Myers spent nine months at Nanking University aiding in the establishment of teaching and research enterprises in plant breeding at that institution. The work was sponsored by the University of Nanking, Cornell University and the International Educational Board.

DR. OSCAR KLOTZ, professor of pathology at the University of Toronto, returned recently from Nigeria, where he has been for the last six months. Dr. Klotz has been investigating the cause of yellow fever under the auspices of the International Health Board.

THE physics department of the University of California announces that Professor A. Joffé, of the Physical Technical Roentgen Institute of Leningrad, Russia, will deliver a course of lectures during the spring semester entitled "The Physics of Crystals." Professor Joffé will be in residence until the end of the semester and will also direct graduate research along these lines.

DR. EDWIN SCHRODINGER, professor of theoretical physics at the University of Zurich, gave a series of lectures at the University of Wisconsin during January which dealt with the theories of properties of matter and with the quantum theory of atomic structure.

DR. JOHANNES WALTHER, of the University of Halle, Speyer visiting professor of geology at the Johns Hopkins University, will arrive at the university this month.

DR. BERNARD GLUECK, psychiatrist, who has recently returned from a year and a half spent abroad, where he has been associated with the European psychiatrists, is to give a course on "The Applications of Psychoanalysis" at the New School for Social Research, during the coming spring term.

DR. FRANCIS G. BENEDICT, director of the laboratory of nutrition of the Carnegie Institution, recently gave an illustrated lecture at the Scientific Institute for Alimentary Hygiene in Paris on "Recent Research on Metabolism in Man and Animals."

THE series of Beaumont lectures of the Wayne County Medical Society, Detroit, were given on January 24 and 25 by Dr. Charles R. Stockard, of Cornell University Medical School. Dr. Stockard's subjects were: "The Internal Secretion Problem," "Internal Secretions and Growth" and "The Biology of the Gonads."

THE presidential address before the Pathological Society of Philadelphia was delivered on January 11 by Dr. Eugene L. Opie on "The Cytology of the Pancreas and Its Relation to the Endocrine Function of the Gland."

DR. VICTOR G. HEISER, director for the East, International Health Board of the Rockefeller Foundation, New York, read a paper on "The Health Work of the League of Nations" at a meeting of the American Philosophical Society, Philadelphia, on February 4.

DR. GEORGE W. MOREY, of the Geophysical Laboratory, Washington, D. C., lectured before the Franklin Institute on January 27 on "The Chemical Basis of Glass Technology." Dr. B. S. Hopkins, professor of chemistry in the University of Illinois, addressed the institute on February 10 on "Illinium."

DR. H. S. LIDDELL, of Cornell University, gave a lecture on "Conditioned Reflexes" before the medical school of the University of Buffalo on January 7.

AT a meeting of the Philosophical Society of Washington on February 5, Dr. N. H. Heck spoke on "Observations while passing through an Unusual Waterspout Formation on the Pacific Ocean," and Dr. W. J. Humphreys on "The Tornado."

ON January 22, Professor C. R. Young, of the University of Toronto, delivered an address to the Royal Canadian Institute on the subject "How Great Bridges are Built." On January 29, Dr. A. H. Leim, assistant director of the Atlantic Biological Station, St. Andrews, N. B., delivered an address to the institute on "The Scientific Exploration of the Sea."

MORE than two hundred students, friends and associates of the late Dr. John H. Howland, former professor of pediatrics at the Johns Hopkins Medical School, attended services held in his memory on January 29 in the Civil Engineering Building at Homewood. Addresses were made by Dr. William H. Welch, Dr. Simon Flexner, Dr. William G. MacCallum and Dr. Graham Lusk. Dr. Frank J. Goodnow presided.

FRIENDS and former students are establishing a scholarship fund at Clark University in memory of the late Dr. Edmund C. Sanford, who was professor of psychology at Clark University.

THE Serbian government has awarded the cross of the Royal Order of St. Sava, posthumously, to the late Dr. Ernest P. Magruder, who lost his life in the typhus epidemic in Serbia following the World War.

Dr. Magruder was clinical professor of surgery at Georgetown University Medical School.

FRIENDS of the late T. S. P. Strangeways, who was lecturer in pathology at the University of Cambridge, are forming a memorial fund of which the primary object will be the provision of scholarships for his five sons.

DR. GEORGE BYRON GORDON, director of the University of Pennsylvania Museum and formerly assistant professor of anthropology in the university, died on January 30. Dr. Gordon was fifty-six years old.

CLIFFORD R. PETTIS, superintendent of New York State forests for twenty-seven years and well known authority on reforestation, died on January 30, aged fifty-three years.

THE death is announced, at the age of seventy-four years, of Dr. E. H. Rennie, who had been for more than forty years professor of chemistry in Adelaide University, Australia.

HATON DE LA GOUPILLIERE, formerly director of the School of Mines at the University of Paris, died recently at the age of ninety-seven years.

THE first annual conclave of the American Institute of Chemists will be held at Yale University in New Haven, Conn., on March 28, 1927. A program of unique character is being arranged by a special committee representing the institute and will consist of an afternoon symposium devoted to the subject of "Chemists Contracts," to be discussed by experts prominent in their respective fields. A subscription dinner will be given at six o'clock, and in the evening at eight-fifteen o'clock a public meeting will be held in Woolsey Hall under the joint auspices of the institute and Yale University and to be addressed by a speaker of national prominence. This evening address will be broadcasted through station WTIC of the Traveler's Insurance Company of Hartford, Conn. The sessions of the symposium and the evening lecture are both open to the public. Announcements of the completed conclave program will be published when final arrangements have been made. The forenoon of March 28 will be kept open for trips to points of interest in New Haven and for visiting the buildings and exhibits of Yale University. The afternoon conference of the conclave will be held in the large lecture hall of Sterling Chemistry Laboratory and will be in session from one-thirty to five o'clock. All communications regarding the conclave should be addressed to the Secretary of the American Institute of Chemists, 80 Washington Street, New York City.

THE forty-third session of the American Association of Anatomists will be held in Nashville, Tenn., at the school of medicine, Vanderbilt University, on Thursday, April 14, Friday, April 15, and Saturday, April 16.

THE Association of Asphalt Paving Technologists held its fourth regular annual meeting in Chicago on January 13, under the presidency of Hugh W. Skidmore, of the Chicago Paving Laboratory. The morning session was given over to a discussion of reports of technical committees and the afternoon to business and election of officers. The present officers were unanimously reelected for another year and three permanent committees were authorized and chairmen selected. The constitution was amended, making the chairmen of standing committees members of the board of directors.

THE next German Congress of Natural Science and Medicine will be held at Hamburg in 1928 under the presidency of Professor von Eiselsberg, of Vienna. The number of members has increased from 2,500 to 6,000 in the last two years.

Nature states that at the fourth annual meeting of British zoologists in the rooms of the Zoological Society on January 8, it was proposed by Professor Stanley Gardiner, and carried unanimously, "That this meeting represents to the trustees of the British Museum the desirability of equipping zoological expeditions for the purpose of obtaining as full a record as possible of the past and present fauna."

BY authority of the Governor General of Canada in Council, dated January 5, 1927, the museum branch of the Department of Mines at Ottawa has been designated the "National Museum of Canada." The museum was started as part of the Geological and Natural History Survey of Canada in 1843 and was later known as the Museum of the Geological Survey of Canada. On moving into the new "Victoria Memorial Museum" building in 1910 the museum became generally known as the Victoria Memorial Museum, under the auspices of the Geological Survey. In 1921 the museum was created a separate branch of the Department of Mines, where it still remains under the new official designation.

THE Davenport Academy of Sciences, organized in 1867 and well known in the scientific world for more than half a century, has by an amendment to its articles of incorporation changed its name to Davenport Public Museum. It was felt that the new name is more in accord with the development of the institution. It is no longer a group of scientific men nor is its field limited to science. As an enlarged public museum it will cover natural history and archeology as fully as it did, and will cover as well the ancient and modern cultures and civilizations, art and history, with all the activities proper to an active museum of

to-day. The change of name is to be the beginning of the carrying out of a program of gradual expansion adopted by the trustees, looking forward to the still greater museum assured for the future when the full benefits of the Putnam trust fund become available. Among the first things to be done will be the resumption of publication and of certain other activities necessarily suspended on account of conditions during and following the war. Dr. George E. Decker is president of the museum and W. H. Kimball, secretary. Edward K. Putnam is acting director and J. H. Paarmann, curator.

AN anti-evolution bill has been introduced into the Arkansas legislature which provides: "that it shall be unlawful for any teacher in any of the universities, normals and all other public schools of the State of Arkansas, which are supported in whole or in part by the funds raised by general or special taxes levied upon the property of the people of the state, for school purposes, to teach any theory that denies the story of the divine creation of man as taught in the Bible, and to teach instead that man descended from a lower order of animals, or any other source other than divine creation." Any person violating any of the provisions of this act shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not less than two hundred dollars, nor more than one thousand dollars, and in addition thereto shall have his license to teach in any of the schools of this state revoked, and each day said section is violated shall constitute a separate offense.

LUDLOW GRISCOM, assistant curator of birds, American Museum of Natural History, sailed on February 3 on an expedition to Panama. He intends to examine the Caribbean rain forest region in Panama and contrast it with conditions prevailing in the same type of forest further north in Central America and also with the gallery forests of the Pacific slope of Panama. It is expected that the expedition will charter a boat to explore the Pearl Islands in the Bay of Panama, paying special attention to the water bird colonies known to exist there. Mr. Griscom will be accompanied by Mrs. Griscom, who will secure slide and motion pictures of the birds. Mr. Maunsell S. Crosby, a member of the American Ornithological Union, is going as volunteer assistant, and Mr. Paul F. Covel, of the museum department of preparation, as taxidermist. The expedition plans to remain some seven weeks in the field.

THE first of a series of explorations into the interior of Australia is soon to be made by the National Research Council of Australia and the University of Sydney, aided by the Rockefeller Foundation. An expedition will shortly enter the little explored areas of central Australia in an effort to study the nomadic aborigine inhabitants. At a later time visits will be made to the islands of Papua, New Guinea and other mandated territories of the Commonwealth.

THE division of mammals of the U. S. National Museum recently received as an exchange from the Zoological Museum of the Academy of Sciences, St. Petersburg, Russia, a small but interesting shipment of mammals. Although it contained only 17 specimens, 3 of these represented, at various ages, a rare genus of ground squirrel (*Spermophilopsis*) hitherto unrepresented in the collection, together with 7 species and subspecies of various other small mammals new to the collection.

AT the twenty-fifth annual banquet of the Academy of Medicine of Toledo and Lucas County, Toledo, on January 7, Dr. William W. Alderdyce was elected president; Dr. Elmer I. McKesson, president-elect, and Dr. Thomas H. Brown, secretary. According to the *Journal* of the American Medical Association, Dr. James A. Duncan, chairman of the committee on endowment, suggested that a fund of $300,000 be raised for research by the academy, and announced that he had provided in his will for a bequest of $50,000 toward that purpose.

DR. HERMANN HILLE has donated $1,000 to the University of Chicago for a fellowship in the department of physiology for the year 1926–27, to be known as the Hille fellowship in physiology, and has guaranteed further sums not to exceed $500 as an expense fund in connection with the fellowship.

THE board of estimate of the City of New York has voted the sum of $50,000 to be used for reconditioning the Smith mansion in Brower Park for an annex to the Brooklyn Children's Museum. This will give the museum additional space equal to the size of the present building, and the plot of ground, which measures 250 by 250 feet, is of sufficient size to permit of the erection of an auditorium when funds are available.

ACCORDING to the *Journal* of the American Medical Association the president has transmitted a request to congress that an appropriation be made of $5,000 for the payment of expenses of five delegates from the United States to the Congress of Military Medicine and Pharmacy to be held in Warsaw, Poland, this year. The request is made that three of these delegates shall represent, respectively, the medical service of the war and navy departments, and the U. S. Public Health Service. The request was initiated by the government of France through a resolution adopted at the third International Congress of Military Medicine and Pharmacy held in Paris in 1925.

THE Industrial Alcohol Manufacturers Association has founded an Industrial Fellowship in the Mellon Institute of Industrial Research of the University of Pittsburgh, for the purpose of studying denaturants, in order to find an ideal one, if possible. This would be a substance possessing such properties and physiological action that it would render ethyl alcohol undrinkable, but could not be separated in any way from the alcohol and would not injure it for technical uses.

UNIVERSITY AND EDUCATIONAL NOTES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY has received a grant of $230,000 for an aeronautical engineering building made by the trustees of the Daniel Guggenheim Fund for the Promotion of Aeronautics. The gift will provide a building to house the present personnel and equipment and marks the first step in a program of expansion which, with new apparatus and additional room, will give the institute unexcelled facilities for instruction and research in aeronautics.

A GIFT of $11,450 has been made to the Harvard Medical School to be known as the Henry Ehrlich Memorial Fund, the income to be used for the assistance of needy or worthy students.

PRESIDENT JOHN A. COUSENS has announced that the proposal to move the Tufts Medical School from Boston to Medford has received the approval of the college trustees and is now before the alumni for action.

A GIFT of £74,000 from the International Education Board, New York, to the University of Edinburgh is to be applied toward the cost of a new department of zoology, which is to be created at the King's buildings of the university. Of the total sum £38,000 is for buildings, £10,000 for equipment and £26,000 for endowment.

THE University of St. Andrews, Dundee, will benefit to the extent of £25,000 under the will of the late William Gibson, Dundee. This sum becomes payable on the death of the testator's two sisters, and is to be used to build and equip a laboratory for study and research in pathology and bacteriology.

DR. OWEN L. SHINN, professor of applied chemistry at the University of Pennsylvania, has been appointed director *pro tempore* of the John Harrison laboratory of chemistry at the university. This appointment follows the action of the university's trustees in acceding to the request of Dr. Walter T. Taggart, present director of the laboratory, to be relieved of administrative duties.

AT Cornell University, Professor W. A. Hurwitz has been made chairman of the department of mathematics.

DR. E. W. TSCHUDI, formerly of the Nela Research Laboratory, Cleveland, Ohio, has been appointed head of the department of physics at Winthrop College, S. C.

DR. JOSEPH CHANDLER, formerly associate professor of chemistry at Boston University School of Medicine, has been appointed associate professor of chemistry at Hahnemann Medical College, Philadelphia.

DR. F. C. HARRISON has resigned as principal of Macdonald College to devote his entire time to research and the training of graduate students. Dr. W. H. Brittain, professor of entomology at the Nova Scotia Agricultural College and provincial entomologist for Nova Scotia, has been appointed professor of entomology in the college.

DR. EGON SCHWEIDLER has been appointed professor of experimental physics at the University of Vienna.

QUOTATIONS

CHILE AND THE CHEMISTS

CHILE faces an economic crisis. She must decide whether to reduce or even abolish her nitrate export tax, from which she has long derived 40 per cent. of her revenue and out of which she has built ports, railways and other permanent improvements. Her nitrate production has declined from 377,000 long tons (in terms of pure nitrogen) in 1925 to 290,000 in 1926. According to *The Wall Street Journal,* the shares of five great nitrate companies have fallen on the London Stock Exchange from an aggregate quoted value of £3,578,000 on January 1, 1926, to £1,634,000 on December 31, 1926.

It might be concluded that Chile's nitrate beds are rapidly nearing exhaustion. But turn to a report of the Inspector General of Nitrate Deposits for 1923. There we are assured that Chile's saltpeter resources could supply the world with the raw material of fertilizers and explosives for at least two centuries, even at the annually increasing rate of consumption that prevailed until recently. But *The Wall Street Journal* calls attention to the increased production of "synthetic nitrogen." That explains everything. It is our irrepressible and resourceful friend, the research chemist, who is responsible for Chile's plight. For a generation he has been struggling with that obstinate gas, nitrogen, to make it assume a substantial and usable form. He built electric furnaces, burnt the oxygen out of the air, and in this way obtained a cer-

tain amount of nitrogen fixed as acid. He created entirely new nitrogenous compounds, among them calcium cyanimide. He used pressure of hundreds of atmospheres to force nitrogen and hydrogen into combination in the form of ammonia. He looked the old-fashioned coke-oven over, and, horrified at its waste of valuable nitrogen, proceeded to devise a retort which would yield ammonium sulphate as a by-product.

Now Chile and the London Stock Exchange must take account of his work. The production of synthetic ammonia in 1926 seems to have been equivalent to 650,000 tons of pure nitrogen—more than twice that of Chile. Had it not been for the British coal strike and the depression in the iron and coke industries, an additional 340,000 tons would have been obtained as sulphate of ammonia. As it is, by-product ovens accounted for 240,000 tons of that form of nitrogen. Chile must at least reduce her export tax, and the companies that exploit her greatest natural resource must engage a few first-class research chemists to devise more economical methods of treating the nitrate scooped from the earth. What research has destroyed research may also save.

The chemist may be pardoned if he smiles as he reads the "prices current" for Chilean and synthetic nitrates and notes that there is more than a full year's visible export stock of Chilean nitrate to be disposed of and scarcely no stock at all of synthetic nitrate. For years he has been dinning the gospel of research into the ears of bankers and manufacturers. Now that his synthetic ammonia has broken a monopoly to which every nation long paid tribute, his audience is larger and more attentive. We actually believe him when he assures us that he can make gasoline in a factory and sell it in competition with natural motor-fuel, or that some day he will make synthetic rubber so cheaply that we can pave streets with it.—*The New York Times.*

DISCUSSION AND CORRESPONDENCE

ILLINIUM

IN a copy of *Gaz. chim. Ital.* (*56,* 862 (1926)) received a few days ago, Professor Rolla, of Florence, claims priority for the discovery of Element No. 61 and proposes for it the name Florentium on the basis of a "Plico Suggellato" filed in June, 1924. Professor Rolla began his search for the element early in 1922; see *Z. anorg. allgem. Chem., 157,* 571 (1926). In making his claim for priority he was, apparently, not aware of the following facts:

In 1919 the University of Illinois and the U. S. Bureau of Standards entered on a joint investigation of the arc spectra of rare earth elements, using materials resulting from long continued fractionations carried out at the University of Illinois. The results of this investigation were published in the U. S. Bureau of Standards Scientific Papers, *421* (1921), *442* (1922), *466* (1923). In the second of these papers, published at about the time that Professor Rolla began his work and two years before his "Plico Suggellato" was deposited, Dr. Kiess, who carried out the spectrometric studies, reported 130 spectral lines which were common to the spectra of Neodymium and Samarium, in the samples submitted to him by Professor Hopkins, and says, "These lines are of unknown origin and may belong to the missing element of order No. 61, coming between Neodymium and Samarium." In January, 1924, again five months before the deposit of Professor Rolla's document, L. F. Yntema published an article, "Observations on Rare Earths. XV. A Search for Element 61," in which he gives five additional lines in the ultra violet region and repeats the statement that these probably belong to Element No. 61. See J. Amer. Chem. Soc., *46,* 37 (1924). Finally, on the basis of still further work, including the finding of two X-ray lines of the L series, J. A. Harris with B. S. Hopkins announced the discovery of Element 61 and proposed the name Illinium. See J. Amer. Chem. Soc., *48,* 1594 (1926).

In the light of these facts, it would seem that the honor for the discovery of No. 61 belongs primarily to Professor Hopkins and that the element should be called Illinium rather than Florentium. This does not detract from the credit which Professor Rolla should receive for his independent discovery of the element. Both Professor Rolla and Professor Hopkins realize that a very large amount of additional work must be done before the element can be fully accepted.

W. A. NOYES

URBANA, ILL.,
JAN. 29, 1927

CONCERNING THE RING METHOD FOR MEASURING SURFACE TENSION

WHEN looking over the literature of the past five years, the writer can not refrain from being highly gratified by the large number of papers published on the ring method for measuring surface tension. Indeed, he can not help but feel that he is responsible to a certain extent for this sudden interest in a very old method as, previous to his first paper describing his instrument (a combination of the ring and of the torsion balance, 1919), so little attention had been given to the technique of the ring that hardly two or three workers had used it in twenty years. A few of the recent articles, however, are critical and tend to establish the inaccuracy and the unreliability of the method which he advocates. Some of them,

signed by the best authorities on surface tension, are of great interest, but, as they strongly emphasize the shortcomings of the *instrument* itself, now on the market, they are likely to throw discredit on the *method* which we maintain to be the best for the study of colloids. Therefore, the writer thought it necessary to add a few words to this discussion. It has never been his intention to claim that the dimensions which he chose for the stock platinum ring were the ideal ones, for *all* kinds of work. No stock instrument can claim so much, not even stalagmometers and glass tips. For standard work of the highest accuracy, the glass tips have to be carefully calibrated and ground by the experimenter, and are not on the market. The same applies to capillary tubes. For very small values of surface tension, it is advisable to use tips of a different size than those used for water and certain aqueous solutions. This is true of practically every physical apparatus. There is no doubt that a knife-edge ring, such as is used by Dr. Klopsteg and myself in certain careful measurements, is better than the ordinary stock platinum ring with a circumference length of 4 cm. But the tensiometer was made principally to determine *very rapidly* the surface tension of a small quantity of liquid with accuracy and was particularly intended for the study of the time effect on aqueous colloidal solutions; now, the values obtained for pure water are in excellent accord with those accepted as standards, from which they differ by less than $\pm$ 0.1 dyne. The agreement is better than that which is to be found in the data published by different authors using drop weight methods. This was considered as satisfactory. Dr. Johlin (SCIENCE, 1926, lxiv, 93), acknowledges the fact and explains it by stating that the "approximately correct (?) values found with the ring supplied with the instrument are the result of the cancellation of equal and opposite errors." This is indeed a great compliment to the instrument, in fact the greatest that can be made to any instrument. Further, he states that the value obtained for benzene is too high. Probably he considers the data obtained with the capillary ascension method as the absolute standards. But this method is known to give lower values than the others, and has been seriously criticized by a number of excellent authorities, A. Ferguson among others. In the tables, the surface tension of ethyl alcohol is given as 22 dynes at 20° C. (Ramsay and Shields, capillary ascension), but Grunmach found 26.1 dynes at 17.7° C. (capillary waves), and Freundlich ("Capillary Chemistry," 3d ed., p. 43 of the English translation) quotes 21.6 dynes at 25° C. These values do not agree. When a liquid is in contact with its vapor, the readings are different from those obtained when it is in contact with air. As long as no absolute theoretical values of the surface tension of pure liquids are available, it is impossible to condemn a method because, under certain conditions, in the case of certain liquids, it does not agree with another.

In addition, I have lately read with great satisfaction a letter by Professor Harkins in *Nature,* in which he states that he and his collaborators have worked out a correction formula for the ring method reducing the errors to one per cent., in all cases, and that they hope to reduce them eventually to one tenth of one per cent. Such a statement issued by one of the greatest authorities on surface tension ought to settle the question definitely.

Dr. Johlin, in his paper in SCIENCE, evidently aiming to correct the writer, says that "two hours can not be assumed as sufficient for reaching the state of even approximate equilibrium. Frequently the change following an initial period of two hours is several times as great as it was in this initial period."

I feel sure that Dr. Johlin will give me credit for not having overlooked such a possibility and that he has understood, as I have, that the time necessary to reach an equilibrium is function of the concentration, of the mobility of the molecules or particles in solution and of the distance they have to travel to reach an adsorbing surface. The latter condition may be expressed by the value of the ratio $\frac{\text{Surface}}{\text{Volume}}$, the importance of which has been emphasized in my book. A stable value is attained in less than two hours when 2 cc of a sodium oleate solution at concentrations between 1/25,000 and 1/1,000,000 are contained in watch-glasses; 100 cc of the same solutions will require at least sixty-four hours to reach their equilibrium when placed in a petri dish 10 cm in diameter (see "Surface Equilibrium of Biological and Organic Colloids," p. 174).

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THE BASIS OF REFLEX COORDINATION

IN SCIENCE, Vol. LXIV, No. 1650, A. Forbes has raised some objections against my theory of specific accord between the excitations sent off by the central nervous system and the motor end-organs. My theory is based on two main points:

(1) On the phenomenon discovered by me[1,2], and since confirmed by G. Hertwig,[3] Detwiler[4] and W.

[1] P. Weiss, Arch. f. mikrosk., Anat. u. Entwicklg. mech., Bd. 102 (635)—1924.

[2] P. Weiss, *Jour. Comp. Neur.,* Vol. 40 ( )—1926.

[3] G. Hertwig, Sitzungsber. d. natur-forschd. Gesellsch. Rostock, Vol. 1, 192.

[4] S. R. Detwiler, *Jour. Comp. Neur.,* Vol. 38 (461)—1925.

Brandt,[5] that in a supernumerary transplanted limb, when innervated from the limb level of the spinal cord, every muscle enters into action, always at the same time and with the same degree of intensity as does the homologous muscle in the normal limb close to it. It is not quite correct to state, in respect to this phenomenon, as Forbes does, that "the nature of the reflex coordination involved is best illustrated by the fact that in movements of progression all flexor muscles contract together, while the extensors relax, and *vice versa*," for it is easy to evoke experimentally others than progression reflexes, where not all muscles which are synergic in progression work together; in this case, as well as in the supernumerary limb, not all flexors or extensors are found to exhibit contraction at the same time, but only those among them which are homologous to the normal muscles at work.

(2) On the fact that in innervating the transplanted limb the outgrowing nerve fibers during their course are dividing each in several branches, their subsequent distribution being entirely a matter of chance, as there is not any specificity involved in directing the single nerve fibers. So at least the great majority, if not all, of the motor ganglion cells innervating the supernumerary limb have their several peripheral branches ending on muscles of different kinds.

Forbes admits that if this be really the case my statements in respect to "some power to select a special component in excitation" in the muscle would be correct. But he continues: "Weiss furnishes neither proof nor evidence for his assertion that a single motor neurone may innervate antagonistic muscles. . . . The individual spinal root, containing many axons, may so branch as to supply both the normal and the supernumerary limb, but the individual axon may (and probably does) remain unbranched till it approaches the muscle and there distributes itself only to adjacent fibers."

In reality, I did furnish such proofs for my assertion. Every one can see by an exhaustive study of my paper of 1924 that Forbes's conception just mentioned is by no means in accord with the facts or with my statements about these facts. In reconstructing in three animals with supernumerary transplanted limbs the nerve paths, I found and described that the individual axon *does not* remain unbranched till it approaches the muscle. What really happens is, on the contrary, that the nerve fibers cut off by implanting the limb *branch immediately after beginning their outgrowth* and are *widely distributed long before entering the nerve paths* of the limb to be innervated by them. The fiber branches, in running through the pathless scar, do not at all remain together and when reaching the proximal end of the transplanted limb are so confused that, save in exceptional cases, the order of the fibers in entering the different nerve channels of the transplant is quite other than it was in leaving the central nerve stump. So it is clearly seen that it is quite incorrect to believe the fibers to augment only when they have reached the muscle, as Forbes does. The augmentation takes place long before.

In overlooking this point, it may be easy to give an interpretation of the observed phenomenon on the basis of the classical nervous physiology and there would not be any need to accept my theory. However, recognizing the haphazard disorder of the outgrowing and dividing fibers, as proved by my microscopical examinations, and as recorded in my paper of 1924, we are obliged to accept a resonance-like mechanism involved in the nervous action on the muscle system.

The statement of the older theory that coordination of muscular action is determined within the central nervous system remains untouched by my theory. Only one point must be changed; whereas, after the former theory, the central coordinations were believed to depend on a geometrical distribution of excitation on the paths connected with the muscles to be brought to work at the given moment, it consists, in the new theory, of a dynamical selection of specific excitation forms adapted to the different muscles (the selection may perhaps consist in the excitation of centers which produce discharges just of these forms).

A resonance theory in such a general form as I proposed is the only explanation I can think of which in all respects is in concordance with the facts observed. To bring it in accord with the opinions of nerve physiology generally held will be a matter of future investigation. There are, it is true, many discordances; especially, as is pointed out by Forbes, there is a striking incompatibility between a resonance theory and an all-or-none-principle. But, is the all-or-none principle one of normal reflex action? It may be, as is Forbes's opinion, that there is no definite proof *against* the assumption that this principle would hold good not only for the inadequate stimulation of the nerve itself, but also for the adequate central innervation. I may point out, however, that, on the other hand, there is no convincing evidence or proof to *confirm* this assumption.

For all further information I may refer to an extensive publication of my theory which will appear in a few months.

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[5] W. Brandt, Arch. f. mikr., An. u. Entw. mech., Vol. 106 (193)—1925.

"SINGING" EARTHWORMS

AN article in the *Literary Digest* of October 9, 1926, has been sent to me by Professor Jesse E. Hyde, of Western Reserve University, because he remembered my mentioning the observation of sound-producing earthworms. The article reports, under the heading "When the Earthworms sing Together" the observation of Professor Mangold, of Freiburg, Germany, that "the earthworms possess voices and that they actually are in the habit of uttering slight sounds, and that they do this not singly but in series marked by definite and varying rhythm."

Seeing that the fact that earthworms make noises had not been known before, as I had assumed, I wish to record the observation that also American earthworms produce sound.

It was first pointed out to me by Mrs. Ruedemann about a decade ago, on a sultry May evening, that the earthworms in our garden back of the house could be distinctly heard. Being incredulous at first, I sat quietly on a chair until I also heard an exceedingly fine rasping noise all around me. It was a chorus of almost unbelievably small voices in the dark. To find out whether the little musicians were really earthworms, I got a flashlight and when the voices, after the quiet resulting from the disturbance of walking over the ground, were again in full chorus, turned the light upon a point close to me, from which I was sure a rasping sound arose. The light revealed a large earthworm, partly stretched out of its burrow. I spotted several more afterwards. We two have since heard the singing every year, always on warm spring evenings about and after dusk. Mrs. Ruedemann also heard it last spring about 4 o'clock in the afternoon on a warm May day after a rain, and then she could see the "singing" worms all partly stretched out of their burrows.

From the rasping character of the sound and the position of the worms I inferred that the noise was made by the drawing of the setae over some hard object at the edge of the burrow, and the time of the year suggested that the concert is connected with the mating season of the worms. Professor Mangold, on the other hand, concludes that the sound is made through the mouth and is more of the character of clicks, which however may "sometimes become so rapid as to form a buzzing noise." These noises were made only in the burrows in his aquarium.

A member of the museum staff, Mr. Jacob Van Deloo, tells me that he heard the sound frequently, when a boy.

Not being aware that this "musical talent" of the earthworms was unknown to naturalists, I failed to catch some of the musicians for identification. Dr. S. C. Bishop, of the New York State Museum, intends to make a study of this, this spring.

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ENGLISH VERSUS METRIC SYSTEM

THERE has been considerable agitation for replacing our English system of weights and measures with the metric system.

One of the most striking examples of the unscientific way in which the English system of weights and measures has grown up and the confusion that it introduces is given in the following sentence taken from a paper on "The Effect of flooding with Sea Water on the Fertility of the Soil," by H. J. Page and W. Williams, of the Rothamsted Experimental Station, Harpenden, England, and published in the *Journal of Agricultural Science,* Vol. XVI, Pt. 4, pp. 551–573 (1926).

> The land is typical strong wheat and bean land which can ordinarily be expected to give a yield of four to five quarters of wheat per acre.

I am supposed to be familiar with the English language, and yet the quantity, "a quarter of wheat," was a new term to me. I accordingly looked it up in Funk and Wagnall's New Standard Dictionary (unabridged) and found that the following possibilities present themselves.

(1) The fourth of a hundred weight (this would mean 25 pounds).
(2) By the old reckoning, the fourth of a hundred weight, where the hundred weight is 112 pounds, namely, 28 pounds.
(3) Eight bushels, with the parenthesis following it (in some localities, 8 3/4 or 9 or 12 or 16 bushels, etc.).
(4) A fourth of a ton. (Query: Is a short ton, 2,000 pounds, or a long ton, 2,240 pounds, meant?)

Apparently the dictionary had not helped me very much in deciding what the authors meant by "a yield of four to five quarters of wheat." It would have been just as intelligible to me if they had stated "two or three cart loads" and had neglected to state the size of the cart. Accordingly, I asked some of our graduate students from Canada what was meant and they said that we would have to find out what a "quarter" meant at the particular grain market where the wheat was sold, in order to decide what the authors meant in this scientific paper.

If the English system of weights and measures can

be a source of so much confusion to one to whom English is the native language and who has been brought up to use the English system of weights and measures, how much greater must be the confusion to a person brought up on the relatively simple metric system and perhaps attempting to read a paper in a tongue which is foreign to his own and to translate these units into the metric system! If we can not have the metric system in everyday life, let us at least have it in our scientific journals!

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SCIENTIFIC BOOKS

Cloud Studies. By ARTHUR W. CLAYDEN, M.A. Second Edition. E. P. Dutton and Co., N. Y.

STUDENTS of nature should be pleased that another edition of Clayden's "Cloud Studies" is now available. Mr. Clayden has given a great deal of time to developing the art of cloud photography and the result is a series of beautiful cloud photographs which should introduce any reader to a knowledge of the different cloud forms. These cloud forms are called by the names adopted at the International Meteorological Conference at Munich in 1891, a modification and extension of the cloud nomenclature introduced by Howard in 1803.

Mr. Clayden has been an enthusiastic observer as well as a photographer of clouds and in his introduction he tells how to observe clouds easily by means of a blackened mirror. Such a mirror diminishes the glare and brings out in a wonderful manner the detailed structure of the finest cirrus and enables one to observe right up to the edge of the sun. It enables one to view the clouds looking downward instead of in the unnatural position of stretching the neck and the face upward. In the more comfortable position of gazing downward into the mirror long-continued observations may be made and one form of cloud can be watched changing into another.

Beginning with the highest cloud forms Mr. Clayden takes up in succession the different forms of clouds beginning with the highest. In chapter III he pictures, describes and names no less than nine forms of cirrus, quite distinct from each other; but some of these are transition forms and border closely on cirro-cumulus and cirro-stratus. Chapter IV is devoted to cirro-stratus and cirro-cumulus, and numerous examples of each form are given. It is difficult to photograph the widely extended sheets of cirro-stratus so that most of the photographs partake of the cirro-cumulus type. Chapter V takes up the "Alto" clouds, alto-stratus and alto-cumulus. It is almost impossible to photograph the widespread, almost uniform, dark sheets of alto-stratus so that most of the examples given are of alto-cumulus. Chapter VI is devoted to the lower clouds, stratus, strato-cumulus and nimbus. The different types are illustrated by photographs, but these are much less satisfactory than those of the upper clouds. Owing to the absence of color in the photographs it is difficult for an inexperienced person to tell whether dark patches are clouds or sky. This difficulty can be overcome only when it is possible to photograph in colors.

In chapter VII he takes up the cumulus which is perhaps, the best known cloud and easy to photograph. In chapter VIII is described the cumulo-nimbus or shower cloud. Some photographs show the anvil-shaped top of the cloud and others the massive cumulus-like structure of the cloud. Here again we miss the absence of color to distinguish cloud from sky. In chapter IX he discusses clouds which form in wave-like lines and ripples and finally in chapter X has an excellent description of methods of photographing clouds and of determining cloud heights by photography.

The strength of the treatise lies in its photographs and descriptions of clouds. Mr. Clayden has clearly been a student of nature and not of books. His discussion of how clouds are formed and the physical processes involved is very inadequate. It is true that he rightly attributes cloud formation to adiabatic cooling of moist air by expansion and refers to the work of Aitken and Wilson as to the necessity of nuclei for condensation of moisture in droplets. He makes no mention, however, of the usual formation of cloud sheets in inclined strata and ignores the work of Bjerknes and other writers who show that the chief cause of cloud formation and of the ascent of air in inclined strata is the contrast of adjacent bodies of air at different temperatures and the overrunning of colder air from the direction of the pole by warmer air from the south and east.

H. H. CLAYTON

Die Vögel Mitteleuropas. Herausgegeben von der Staatl. Stelle für Naturdenkmalpflege in Preussen. By DR. OSKAR and FRAU MAGDALENA HEINROTH. Hugo Bermühler Verlag, Berlin-Lichterfelde. Lieferungen 1–10; 1924–1925; pp. 1–80; 16 colored plates; 42 black plates.

THE first ten parts of this work appeared between July, 1924, and April, 1925. They are devoted to an account of part of the order Passeriformes of central Europe, *i.e.*, Germany, and they include the wren, water ouzel, accentors, thrushes, flycatchers, waxwing, shrikes, swallows, and the beginning of the Old World warblers, in all thirty-one species.

There is given a brief general statement regarding the families to which these belong and the more or less convenient groups into which the authors divide some of the families. There is also of each species an account, which, while it does not go into technical details, gives habits, measurements, and geographic distribution, though usually not a complete description of adult plumages. While no attempt is made to provide a full life history, the material given throws much interesting light on the birds treated, and in some cases is considerably extended. The text is made up in large part of original life history observations of birds in the field and in captivity, and for this reason the accounts of the various species differ much in length, according to the opportunities of the authors.

Much exceedingly interesting information is given on the song, notes, nesting habits, the young, and the general behavior of the different birds. In the exactness of the data presented, the text gives excellent evidence of the care with which the observations have been made. Of particular value are the notes on the development of nestling birds, with specific data on the age of each stage of plumage, information which every one who has had occasion to search for realizes is difficult to obtain, and furthermore, all too rare in books on birds. Dr. Heinroth has for a great many years been able to rear large numbers of birds in captivity, and this has given him an unexampled opportunity to determine many facts which would easily escape the chance observer in the field, but which are of great importance, nevertheless. Some of the longer accounts of the life history of the species treated are especially good and amount almost to a monograph of the behavior of the species. Worthy of particular mention are those of the nightingales (*Luscinia megarhyncha* and *Luscinia luscinia*), the blackbird (*Turdus merula*), the spotted flycatcher (*Muscicapa striata*), the robin (*Erithacus rubecula*) and the swallow (*Hirundo rustica*). The book is not a technical treatise, but is designed to present an interesting side of the life history of the birds of the author's region.

One of the most important features of "Die Vögel Mitteleuropas" is the wealth of illustration. The numerous plates are, however, issued apparently as material was obtained for their completion, or as convenience dictated, since but in few instances do they illustrate the species described in the parts in which they appear. Both the colored and the uncolored plates are made up with the idea of showing the development of the species figured, from the egg through the nestling and juvenal plumages up to that of the adult. The value of these plates is greatly enhanced by the circumstance that they represent the various stages of plumage at precisely known ages of the birds, in this admirably supplementing the descriptions given in the text.

If the standard already set in the parts now discussed should be maintained, as we have every reason to believe it will be in the parts yet to be published, we are probably not saying too much when we predict that this work will prove to be one of the most important contributions to the life history and behavior of European birds that has appeared in many years.

HARRY C. OBERHOLSER

SPECIAL ARTICLES

THE FIBRILLAR STRUCTURE OF THE DENTAL ENAMEL MATRIX OF THE GUINEA PIG

RECENTLY we[1] have outlined certain morphological findings with regard to the organic matrix of guinea pig dental enamel. Preparations were made from material carefully decalcified through celloidin. By such a method, sections of this structure may be demonstrated.

Carter[2] has claimed that in the formation of enamel, globular material is laid down irregularly and "that there is no sign of any merging of the cells into the secretion such as one would find did the ameloblasts themselves become transformed into a stroma which became incorporated into the enamel." Our sections show that protoplasmic processes may extend from the ameloblastic layer into the enamel structure. These taper away to a point within a distance of from ten to fifteen microns. Thus, there is in the guinea pig a definite articulation between these two elements, as shown by Van Giesen stain.

Moreover, when the matrix is drawn away from the ameloblasts by the pull of the microtome knife, the organic matrix may split or tear. This rupture, however, is in a plane parallel to the length of the enamel rods. Fibril-like structures thus are formed. This result is produced likewise when the direction of tension does not coincide with the length of the enamel rods but lies at an angle with them. We have photomicrographic evidence of these observations.

These results tend to show that a protoplasmic fibrillar structure may connect the ameloblastic layer with enamel matrix in the guinea pig and that the matrix itself appears to be of fibrillar structure. Thus, we do not coincide with the belief that the formation of dental enamel is an irregular deposition of precipitated material. Rather, precipitation of calcareous

[1] Beckwith, T. D., and Williams, A., Proc. Soc. Exp. Biol. and Med., 1926, 24, 76.

[2] Carter, J. T., *Quart. Journ. Micros. Soc.*, 1918–19, 63, N.S., 387.